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## REVIEWS

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*The Origin of the Magmatic Sulfid Ores.* By C. F. TOLMAN, JR. and AUSTIN F. ROGERS. Leland Stanford Junior University Publications, 1916. Pp. 76, figs. 7, pls. 20.

After reviewing the literature bearing on the modes of origin of the various magmatic ore deposits, the authors have proposed as their thesis that "the magmatic ores have in general been introduced at a late magmatic stage as a result of mineralizers and that the ore minerals replace the silicates. This replacement, however, differs from that caused by destructive pneumatolytic or hydrothermal processes in that quartz and secondary silicates are not formed at the time the ores are deposited."

The authors follow the position taken by Bowen in his recent work establishing the process of fractional crystallization as the dominant one during magmatic differentiation. After studying suites of specimens from Sudbury, Ontario, Elkhorn, Montana, Ookiep, South Africa, and Plumas County, California, the conclusion is reached that the ores have been introduced by pneumatolytic means after the formation of the rock-bearing silicates. The authors show clearly that the sulphides are a late magmatic product, that they surround the silicates, cut them with well-defined veinlets, embay them, and penetrate cleavage cracks and contacts with other minerals. The absence of metallic silicates makes it clear that the ores were not introduced as molten material, while the replacement of early formed minerals indicates the presence of mineralizing solutions. The complete absence of reaction rims shows that the replaced material was removed by the same agents which introduced the ores. Selective replacement is shown by the preservation of the original graphic texture of the rocks in the ores. There is also evidence of the alteration of pyroxene to hornblende prior to the introduction of the ore minerals, suggesting the presence of aqueous vapor. The small amounts of hydrothermal alteration present appear to be related to a post-magmatic stage.

The authors conclude that the temperatures involved in the deposition of the ores did not exceed 300 C. to 400 C., but it is unsatisfactory so to limit the temperature without further data than are here presented.

That the temperatures were higher than those of pegmatites is admitted by the writers, but the only thing certain about the temperatures of the pegmatites is that some minerals in some pegmatites formed at temperatures lower than  $575^{\circ}$  C. The dominance of pyrrhotite as compared with pyrite is recognized, and this indicates a high temperature, since pyrite is less stable than pyrrhotite at such temperatures.

The paper represents an excellent piece of work and is a distinct contribution to the knowledge of magmatic processes. It also serves to emphasize the fact that a great deal must be known concerning the minute textures of rock masses, other than that they are merely juxtaposition, before positive conclusions may be reached as to the sequence of crystallization.

E. A. STEPHENSON

CHICAGO

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*Relations of Cretaceous Formations to the Rocky Mountains in Colorado and New Mexico.* By WILLIS T. LEE. Prof. Paper, U.S. Geol. Surv. No. 95-C, 1915. Pp. 27-58, pl. 1, figs. 11.

In this paper physiographic principles are applied to certain phases of the stratigraphy of the southern Rocky Mountains. The geographic conditions during the Mesozoic are discussed and a large number of Cretaceous sections are considered. This study indicates that this basin of Cretaceous deposition was deepest in northern Colorado and southern Wyoming, and that the main mass of sediment came from an ancient land farther west. The sections show, moreover, that the sandstone formations near this ancient continent become thinner eastward, toward the present Rocky Mountains, and are replaced by shales. The author concludes that the conformable Cretaceous formations up to and including the Laramie once extended across the present site of the mountains. Downward warping and deposition in this basin was followed by uplift and erosion. This change is believed to mark the close of the Cretaceous. The formations deposited after the uplift (the post-Laramie formations) belong in the Tertiary.

H. R. B.

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*Review of the Pleistocene of Europe, Asia, and Northern Africa.* By HENRY FAIRFIELD OSBORN. Annals N.Y. Acad. Sci., XXVI, 1915, pp. 215-315, figs. 20, tables 4.

This paper is a revision for the German edition of chap. vi of the author's *The Age of Mammals*.

H. R. B.